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ABSTRACT

During childhood students develop habitual, characteristic, optimistic or pessimistic causal explanations for the everyday events in their lives. Furthermore, they acquire attributional patterns for their educational successes and failures which influence their attitudes, motivations and goals. In this study, relationships between primary and lower secondary school students' optimistic or pessimistic explanatory style, task involvement and ego orientation goals and achievement in mathematics are examined over a period of almost three years. While achievement in mathematics is most strongly related to prior achievement, there are significant relationships between students' explanatory style and achievement in mathematics and between students' explanatory style and task involvement goals. Students' gender and grade level are also important factors. The implications of these findings for education are discussed and suggestions made for future studies. (Contains 43 references.) (Author)

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Students' Explanatory Style, Goal Orientation and Achievement in Mathematics: A Longitudinal Study ®

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During childhood students develop habitual, characteristic, optimistic or pessimistic causal explanations for the everyday events in their lives. Furthermore, they acquire attributional patterns for their educational successes and failures which influence their attitudes, motivations and goals. In this study, relationships between primary and lower secondary school students' optimistic or pessimistic explanatory style, task involvement and ego orientation goals and achievement in mathematics are examined over a period of almost three years. While achievement in mathematics is most strongly related to prior achievement, there are significant relationships between students' explanatory style and achievement in mathematics and between students' explanatory style and task involvement goals. Students' gender and grade level are also important factors. The implications of these findings for education are discussed and suggestions made for future studies.

Introduction

Motivating students to learn is a perennial preoccupation of all teachers at all levels. As a core area of the curriculum, mathematics is studied by all students in primary and lower secondary schools. Motivation and achievement in mathematics are influenced by a variety of factors. Students bring to the classroom a life-time history of explaining the causes of events in their everyday lives, and it is through these predominantly optimistic or pessimistic frameworks that they filter their educational experiences (Seligman, 1990; Schulman, 1995). In addition, in the course of their studies, students adopt educational goals which either enhance or detract from their engagement in the learning enterprise (Duda & Nicholls, 1992). This study examines the extent to which students' optimistic or pessimistic explanatory style is related to their task involvement or ego orientation goals and the relationship of both of these variables to their achievement in mathematics. The gender and Grade level of the students is also taken into account.

Explanatory style

By the age of eight or nine years students have developed a characteristic manner or style of explaining the causes of everyday events in their lives (Nolen-Hoeksema & Girgus, 1995; Seligman, 1990; Yates 1998b). Some students have a negative outlook on life which predisposes them to interpret events from a pessimistic framework, particularly when these events arise from ambiguous causes (Peterson & Bossio, 1991). For pessimists, the causes of negative events are seen as permanent, personal and pervasive and positive events as temporary, outside of their control and specific. For optimists the opposite is the case as it is positive events which are permanent, personal and pervasive and negative events which are fleeting, due to outside effects and specific to that event (Peterson & Bossio, 1991). Within an educational milieu, students with an optimistic framework are likely to interpret failure as a temporary state of affairs which is confined to that task or example and over which they have ultimate control. For pessimists, the same failure is likely to be perceived as being more long-lasting, generic and uncontrollable. Recent work on peoples' explanations for the causes of events in their lives have found linkages between these characteristic optimistic or pessimistic patterns of explanatory style and their health, work and achievement (Peterson & Bossio, 1991). With school aged students relationships have been found between their explanatory style and their general achievement (Nolen-Hoeksema, Girgus, & Seligman, 1986; 1992) as measured by the standardised *California Achievement Test* (California Test Bureau, 1982).

Goal orientation

In classrooms students' attitudes towards and engagement in school work are influenced by learning and performance goals (Woolfolk, 1998). Students who are task involved hold learning goals which motivate them to learn, improve, seek challenges, persist in the face of difficulty and to focus on mastery of the topic or task (Nicholls & Miller, 1984). They are also more likely to believe that ability is incremental (Schunk, 1996) and to seek appropriate assistance (Butler & Neuman, 1995). Students who espouse ego orientation goals are focussed on their performance goals relative to others. They are motivated by the need to appear to be successful, to be better than others and to avoid failure. They are not likely to expend effort on tasks especially when they are difficult, as the very fact of having to make an effort is tantamount to an admission of a lack of ability (Covington & Omelich, 1979). They are also more likely to believe that ability is fixed (Dweck, 1986; Pintrich & De Groot, 1990). Such students are motivated in the classroom only when their performance is being evaluated so they choose tasks and expend effort accordingly (Stipek, 1996) .

Achievement in mathematics

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The need for all students to achieve basic levels of numeracy is considered in numerous documents including the Key Competencies and the *National Statement and Profile on Mathematics for Australian Schools* (AEC, 1990). Mathematics is compulsory for all students in primary and lower secondary schools, yet teachers frequently encounter students who espouse negative attitudes towards the subject. These negative attitudes arise in part from the nature of the subject matter, as success and failure is more salient in mathematics than in other subjects. Some students believe that mathematics is governed by rules and that problems should be able to be solved relatively quickly (McLeod, 1992). In addition, in Western cultures mathematics is often considered to be a subject only for the very able (McLeod, 1992). These attitudes and beliefs influence students' expectations towards mathematics, particularly in relation to failure, and are likely to be reflected in their behaviours within the mathematics classroom. Achievement in mathematics is related also to students' levels of anxiety (Hembree, 1990), self-confidence (Reyes, 1984), self-concept (Marsh, 1986) and self-esteem (Bandura, 1977).

The Study

The fundamental hypothesis of this study is that possessing an optimistic explanatory style leads to greater task involvement and enhanced achievement levels in mathematics. Thus optimistic students are more likely than pessimistic students to report a greater interest in learning mathematics and to show increases in their achievement in mathematics over time. The aims of this study therefore are:

1. to examine the relationships between students' optimism, pessimism, task involvement, ego orientation and achievement in mathematics over time; and

2. to consider the influence of student's gender and Grade level on these relationships.

Method

Participants

The study commenced in Term 1, 1993 with a sample of 335 students in Grades 3 to 7 in two government primary schools in South Australia. In Term 4, 1995, 243 of these students were traced to 26 primary and 24 lower secondary schools in the government and non-government sectors. The Grade level and gender of the 243 students in 1995 are presented in Table 1.

Table 1 Numbers of students by grade level and gender in 1995

Gender	Grade 5	Grade 6	Grade 7	Grade 8	Grade 9	Total N
Male	8	28	21	28	24	109
Female	10	34	22	38	30	134
Combined	18	62	43	66	54	243

Instruments

Mathematics Achievement Test

Students' achievement in mathematics was measured with Form A of the *Progressive Achievement Tests in Mathematics* (*PATMaths*) (ACER, 1984) which consisted of three timed standardised multiple choice format tests. In 1993 students were administered Test 1, 2 or 3 in accordance with the recommendations made in the *Progressive Achievement Tests in Mathematics Teachers Handbook (ACER, 1984). In 1995, students in Grades 5, 6 and 7 were administered Test 1 or 2, Grade 8 Test 2 or 3 and Grade 9 Test 3.*

Explanatory Style Questionnaire

Students' optimistic or pessimistic explanatory style was measured with the **Children's Attributional Style Questionnaire** (CASQ), (Seligman, Peterson, Kaslow, Tanenbaum, Alloy, & Abramson, 1984). The questionnaire consisted of 48 hypothetical statements about good and bad events, with students choosing between two possible explanations for each event.

Goal Orientation in Mathematics

Students' task involvement and ego orientation goals in mathematics were measured with *Your Feelings in Mathematics: A Questionnaire* (Yates, Yates & Lippett, 1993; 1995). Twelve task involvement items measured the extent to which the students were interested in and engaged in learning mathematics while six ego orientation items sampled their competitiveness. The questionnaire also contained 7 filler items. Each statement in the questionnaire commenced with the stem *Do you really feel pleased in maths when ...* followed by a statement that related to student mathematics behaviour. Typical task involvement items were: (Item 1) *you get really busy with the work* and (Item 15) *something you learn makes*

you want to find out more . Ego orientation in mathematics items included: (Item 4) *you know more than the others* and (Item 23) *you score better on a test than others.* Students rated their attitudes towards mathematics on a five point scale ranging from (5) a *strong yes* to (1) a *strong no* .

Procedure

The *PATMaths* , CASQ and *Your Feelings in Mathematic: A Questionnaire* were administered to students in their own schools in Term 1, 1993 and Term 4, 1995. All measures were administered by a male or female researcher with the exception of *PATMaths in one school in 1993, which was administered by school personnel.*

Analyses

Students' *PATMaths* scores from Tests 1, 2 and 3 in 1993 and 1995 were placed on a single Rasch interval scale, using the conversion table from the *Teachers Handbook* (ACER, 1984). The *Children's Attributional Style Questionnaire* and *Your Feelings in Mathematic: A Questionnaire* were analysed with the Rasch scaling procedure to bring them to common interval scales which could be analysed across time (Yates, 1997; 1998a, 1999; Yates, Keeves & Afrassa, 1999). Rasch analysis of the CASQ indicated the viability and independence of two separate scales of *Optimism* and *Pessimism* (Yates & Afrassa, 1994). Factor analysis of *Your Feelings in Mathematics: A Questionnaire* indicated that the questionnaire contained two separate scales of *Task Involvement in Mathematics* and *Ego Orientation in Mathematics* (Yates & Yates, 1996). These four scales were therefore analysed separately.

Students' results for 1993 and 1995 *Optimism, Pessimism, Task Involvement in Mathematics* and *Ego Orientation in Mathematics* scales were equated across time concurrently (Yates & Yates, 1996; Yates, 1997; 1998a). The stability of the scales was determined with both interclass and intraclass correlations. As interclass (r) correlations requires matching sets with equal numbers, the difference between the means of the two sets is not taken into consideration. An intraclass correlation was therefore calculated from a one way analysis of variance, with the difference between the two coefficients indicating the magnitude of the difference between the means of the two sets. Relationships between the students' achievement in mathematics, *Optimism, Pessimism, Task Involvement in Mathematics* and *Ego Orientation in Mathematics* were investigated with correlational and multiple regression analyses.

Table 2 Interclass (r) and intraclass(rho) correlations between the 1993 and 1995 measures of the Optimism, Pessimism, Progressive Achievement Tests in Mathematics, Task involvement in Mathematics and Ego orientation in Mathematics.

N = 243	rho	r
Progressive Achievement Tests in Mathematics	0.36	0.73
Optimism	0.30	0.35
Pessimism	0.32	0.32
Task involvement in Mathematics	0.32	0.34
Ego orientation in Mathematics	0.18	0.20

Results

Stability of the PATMaths, Optimism, Pessimism, Task Involvement and Ego Orientation scales

In the measurement of any human characteristic over time, some variability is expected to occur both in relation to measurement error and to factors such as learning (Keeves, 1994). Interclass and intraclass correlations, shown in Table 2, indicate that the *PATMaths, Optimism, Pessimism* and *Task Involvement in Mathematics* measures are moderately stable over the three year period. The stability of the *Ego Orientation in Mathematics* scale is weak, reflecting in part the small number of items from which the scale was constructed. There is a marked difference between the intraclass and the interclass correlation coefficients for the *PATMaths* tests.

Relationships between students' optimism, pessimism, task involvement, ego orientation and achievement in mathematics over time

The correlations between students' optimism, pessimism, task involvement, ego orientation, achievement in mathematics in 1993 and 1995 and their Grade level and gender are presented in Table 3. The most striking feature of these correlations are the strong relationships between the two measures of achievement in mathematics over time and between the students' Grade level and achievement in mathematics on both occasions. Notwithstanding the strength of these relationships however, significant correlations are evident between students' achievement in 1993 and the concurrent measures of their optimism, pessimism and task involvement. Likewise students' achievement in mathematics in 1995 is significantly correlated with their optimism and task involvement measured in the same year, but not with their pessimism. Students' achievement in mathematics

in 1995 is also correlated significantly with their optimism and pessimism in 1993. In both 1993 and 1995 the relationship between students' optimism and their achievement in mathematics is negative, reflecting the increases in their achievement and the gradual decrease in their optimism across the Grade levels (Yates, 1998a). Gender is not a significant variable, except in relation to explanatory style where females are more optimistic than males in 1993 and males are more pessimistic than females in both 1993 and 1995.

Table 3 Correlations between Achievement in Mathematics, Optimism, Pessimism, Task involvement, Ego orientation in 1993 and 1995 with Grade level and Gender

	2	3	4	5	6	7	8	9	10	11	12
1 MAch 93	0.73**	-0.17**	-0.17**	-0.14*	•	0.13*	•	•	•	0.63**	•
2 MAch 95	-	-0.19**	-0.17**	-0.21**	•	0.18**	0.13*	•	•	0.42**	•
3 Optim 93		-	•	•	0.15*	•	0.17**	•	•	-0.15*	0.13*
4 Optim 95			-	•	•	•	0.26**	•	•	•	•
5 Pessim 93				-	0.32**	•	-0.14*	•	•	•	-0.19**
6 Pessim 95					-	-0.17**	-0.24**	•	•	•	-0.19**
7 Task 93						-	0.34**	0.22**	•	•	•
8 Task 95							-	0.27**	0.26**	•	•
9 Ego 93								-	0.20**	•	•
10 Ego 95									-	•	
11 Grade										-	•
12 Gender										•	-

* $p < 0.05$, ** $p < 0.01$, • correlation not significant

Of particular interest to this study are the significant correlations reported in Table 3 between students' optimism, pessimism and task involvement in 1993 and their subsequent achievement in mathematics in 1995. It had been hypothesised that optimistic students would evidence a greater interest in mastering mathematics and have higher rates of achievement over time. The relationships between these variables are therefore examined with a series of direct entry multiple regression analyses. In Table 4 the analysis of the influence of initial achievement, optimism, pessimism, task involvement and ego orientation in 1993 on achievement in mathematics in 1995 is presented. These regression results confirm students' optimism, pessimism and task involvement in 1993 as significant predictors of their achievement in mathematics two years later. In this analysis, ego orientation is not a significant factor.

Table 4 Regression analysis: Predicting achievement in mathematics in 1995 by 1993 Maths Achievement, Optimism, Pessimism, Task involvement and Ego orientation

1995 Mathematic Achievement Variable N = 243	r	Beta	t	Significance of t
1993 Mathematics Achievement	0.63	0.62	15.45	0.00
1993 Optimism	-0.19	-0.10	-2.15	0.03
1993 Pessimism	-0.21	-0.12	-2.73	0.01
1993 Task involvement	0.18	0.08	1.86	0.06
1993 Ego orientation	-0.02	0.02	0.51	NS
Multiple R = 0.75		F = 51.65		
R square = 0.57		Significance of F = 0.00		

In Table 3 students' achievements in mathematics in both 1993 and 1995 are also strongly correlated with their Grade level. It is therefore necessary to control for the effects of Grade level on achievement in a further regression analysis. The predictive relationship between students' achievement in mathematics in 1995 and their Grade level, optimism, pessimism, task involvement and ego orientation in 1993 is presented in Table 5. In this analysis, students' achievement in mathematics in 1995 is significantly related to the prior measures of their optimism, pessimism and task involvement, with the relationship between both optimism and pessimism and achievement being negative. Ego orientation is not a significant factor.

Table 5 Regression analysis: Predicting achievement in mathematics in 1995 by 1993 Grade level, Optimism, Pessimism, Task involvement and Ego orientation

1995 Mathematic Achievement Variable N = 243	r	Beta	t	Significance of t
1993 Grade level	0.42	0.42	7.63	0.00
1993 Optimism	-0.19	-0.17	-3.07	0.00
1993 Pessimism	-0.21	-0.25	-4.44	0.00
1993 Task involvement	0.18	0.18	3.10	0.00
1993 Ego orientation	-0.02	-0.03	-0.53	NS
Multiple R = 0.55		F = 20.06		
R square = 0.30		Significance of F = 0.00		

Relationships between students' optimism and pessimism and their task involvement and ego orientation

In addition to the influences of prior achievement and Grade level on achievement, in both Tables 5 and 6 there are significant relationships between students' achievement in mathematics in 1995 and the measures of their optimistic or pessimistic explanatory style and task involvement taken two years previously. Clear correlational relationships are evident between students' optimistic or pessimistic explanatory style and their task involvement goals in Table 3. Both the 1993 and 1995 optimism and pessimism measures correlate significantly with task involvement in 1995, while the 1995 pessimism measure is correlated negatively with task involvement in 1993. These results suggest that with the exception of the weak correlation between task involvement in 1993 and the pessimism in 1995, task involvement is more salient in 1995 when approximately half of the students had entered secondary school. Task involvement in 1995 correlates with the prior and concurrent measures of both the optimism and pessimism, with the more distal relationships from 1993 being weak in comparison with the moderate correlations of the proximal variables.

It is therefore necessary to consider through multiple regression analysis whether the weaker relationships between the positive and negative explanatory style in 1993 are predictive of task involvement in 1995. In Table 6, the influences of the 1993 optimism and 1993 pessimism on task involvement in 1995 are presented. The 1993 optimism is a highly significant predictor of subsequent task involvement in mathematics in 1995, although the pessimism measure is also marginally predictive within the 10 per cent level of confidence. This is an interesting finding as it suggests that explanatory style is predictive of subsequent task involvement, with students who are more optimistic during their primary school years more likely to report higher levels of

mastery orientated behaviour over time. As neither the optimism nor pessimism correlate with ego orientation in 1993 and 1995 in Table 3, the ego orientation scale is not considered further in relation to explanatory style.

Table 6 Regression analysis: Predicting Task involvement in 1995 by 1993 Optimism and 1993 Pessimism

1995 Task Involvement Variable N = 243	r	Beta	t	Significance of t
1993 Optimism	0.17	-0.16	-2.54	0.01
1993 Pessimism	-0.24	-0.12	-1.89	0.06
Multiple R = 0.21 R square = 0.04		F = 5.56 Significance of F = 0.004		

Summary of the results

1. Overall, the strong relationships evident between achievement in mathematics over time attest to the importance of prior performance as an indicator of subsequent achievement.

2. Students' achievement in mathematics is also significantly related to Grade level.

3. Students' optimism, pessimism and task involvement are related significantly to their achievement in mathematics.

4. The negative relationships between optimism and achievement reflect an increase in students' achievement in mathematics and a decrease in optimism across the Grade levels.

5. Students' optimistic explanatory style at the primary school level is related significantly to subsequent task involvement in mathematics.

6. Task involvement is positively related to achievement in mathematics.

7. Ego orientation is not related to explanatory style or achievement at any time.

8. While females are more optimistic that males in 1993, males are more pessimistic than females in both 1993 and 1995.

9. Gender is not a significant factor in students' task involvement, ego orientation or achievement in mathematics.

Discussion

The strong relationship between the two measures of achievement over time is not unexpected. Studies have repeatedly identified prior achievement as the single most important predictor of future achievement. Mathematics is a hierarchically organised subject with prior knowledge an important prerequisite for subsequent achievement. The strong relationship between Grade level and achievement also is anticipated as increments in achievement are expected as students are exposed to increasingly greater amounts of teaching and learning over time (ACER, 1984).

The significance of this study lies in its contribution to the understanding of the inter-relationships between optimism, pessimism, goal orientation and achievement in mathematics. Previous research has focussed on the relationship between explanatory style and general academic achievement (Nolen-Hoeksema *et al.*, 1986; 1992). This study extends this finding by demonstrating that explanatory style is related to the area of achievement in mathematics. The hypothesis that optimistic students relative to pessimistic students would evidence higher levels of task involvement over time is supported by this study, but the suggestion that optimism is related to increased achievement in mathematics is not supported. The 1993 *Optimism* does not relate positively to achievement in mathematics in 1995 both before and after the statistical control of the effects of prior achievement and Grade level. Contrary to within grade comparisons, optimism declines with increasing achievement and with the increasing Grade level of the student. However, there are significant positive relationships between students' optimistic explanatory style and task involvement in mathematics and between students' task involvement and achievement in mathematics.

The relationship between explanatory style and goal orientation has not been considered in previous studies. Research on goal orientation stresses that students' adoption of task involvement and ego orientation goals influences their achievement related behaviours in the classroom, but the actual relationship between students' espoused goals and their achievement in mathematics has not been investigated. In this study there are very clear relationships between explanatory style, goal orientation and

achievement, with students with a more optimistic outlook on life more likely to report a greater level of task involvement in mathematics. This elevated level of task involvement leads to a higher level of achievement in mathematics.

Students become more aware of and increasingly exposed to competition as they proceed through school (see, Harter, Whitesell & Kowalski, 1992; Stipek & Daniels, 1988). Perceptions of competency based on these comparisons have the potential to affect school performance (Pressley & McCormick, 1995). While these findings would suggest that ego orientation may become more important over time for this sample of students, significant relationships between ego orientation and achievement were not found. However, the ego orientation scale used in this study is composed of a small number of items and is relatively unstable over time.

The deleterious effects of a pessimistic explanatory style have been linked with academic performance at the tertiary level (Peterson & Barrett, 1987), as well as at school (Nolen-Hoeksema *et al.* 1986; 1992). Seligman and others have frequently asserted that there is a strong relationship between students' explanatory style and their general achievement. Furthermore, researchers have indicated that students with more task orientated goals are more likely to have higher achievement as they invest more in the learning enterprise and persist in the face of difficulties. This study found these assertions to be verified for achievement in mathematics and to hold true over time, although the effects are stronger when students are younger. Students acquire an optimism or pessimistic outlook on life during their primary school years, with some deterioration in optimism evident as students get older. This explanatory style then influences students' task involvement in mathematics which in turn is related to their achievement in mathematics.

Implications for Education

Skill development in the area of mathematics is likely to demand a continuing level of high motivation. Explanatory style is a motivational characteristic that might conceivably impact upon the disposition to maintain effortful responding over extended time sequences. Failure is an inevitable part of learning (Ames & Archer, 1988), but it is the manner in which students' explain the causes of their failure to themselves which is crucial (Pressley & McCormick, 1995). If students can explain the causes of their failures as temporary, specific and due to factors other than their lack of ability, then they may be more likely to persist in the face of adversity, to maintain high levels of effortful responding and to focus on task involvement goals.

Students develop their optimistic or pessimistic outlooks on life during their primary school years, with this explanatory style linked to their subsequent task involvement. All teachers, but particularly those at the primary school level, need to be sensitive to the attributions that students make, particularly in relation to their failures. Intervention studies have been conducted for adolescents (Peterson, 1988; Jaycox, Reivich, Gillham & Seligman, 1995) and college students (DeRubeis & Hollon 1995). This study would suggest that such interventions should begin when students are in primary schools and should target attributions in specific subject areas, particularly as attributions have been found to be subject specific (Marsh, 1986). Students' levels of task involvement are also important considerations. Furthermore, teachers need to be cognisant of the attributions that they make about students' work, particularly in relation to failures.

Suggestions for Future Studies

This study has identified some very interesting relationships between explanatory style, goal orientation and mathematics achievement in primary and lower secondary school students. It seems that having an optimistic framework in the early school years has important implications for the subsequent development of task oriented achievement behaviours and achievement. However, as the striking negative relationship between optimism and achievement as students proceed through the grades has not been reported in previous studies, these results need confirmation. In particular, as this study was confined to the area of achievement in mathematics, relationships between explanatory style, goal orientation and other areas of the curriculum could be considered. A more adequate measure of ego orientation needs to be developed for future studies.

Seligman (1990; 1995) has asserted that teachers play an important role in the development of explanatory style in children, but the mechanisms by which this occurs have yet to be ascertained. While children bring to the classroom habitual ways of explaining the causes of events, teachers also have characteristic explanatory styles. Just as teachers' practices influence students' motivation (Pressley & McCormick, 1995), relationships between teachers' and students' explanatory styles could be explored. So too could be cultural differences in explaining the causes of events. Lastly, it would therefore be useful to investigate the development of explanatory style in younger children and the factors which influence it.

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